CERTIFICATION OF TRANSLATION

I, ***Jung-kum Lee***, an employee of Y.P.LEE, MOCK & PARTNERS of Koryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalty of perjury that I understand the Korean language and the English language; that I am fully capable of translating from Korean to English and vice versa; and that, to the best of my knowledge and belief, the statement in the English language in the attached translation of ***Korean Patent Application No. 10-2003-0011955*** consisting of ***24*** pages, have the same meanings as the statements in the Korean language in the original document, a copy of which I have examined.

Signed this 25th day of July 2008

Leejungkum

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I, ***Jung-kum Lee***, an employee of Y.P.LEE, MOCK & PARTNERS of Koryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalty of per jury that I understand the Korean language and the English language; that I am fully capa ble of translating from Korean to English and vice versa; and that, to the best of my knowl edge and belief, the statement in the English language in the attached translation of ***Korean Patent Application No. 10-2003-0011955*** consisting of ***24*** pages, have the same meanings as the statements in the Korean language in the original document, a copy of wh ich I have examined.

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ABSTRACT

[Abstract of the Disclosure]

Provided is a compatible optical pickup which can be compatibly used for first through third recording media having different recording densities and formats. The compatible optical pickup includes a single light source which emits a first light beam having a wavelength suitable for the first recording medium; a twin light source which emits second and third light beams respectively having wavelengths suitable for the second and third recording media; a first objective lens which condenses the first light beam to form a light spot for recording and/or reproduction of the first recording medium; a second objective lens which condenses the second and third light beams to form light spots for recording and/or reproduction of the second and third recording media; an actuator which drives the first and second objective lenses; a first photo-detector which receives the first light beam reflected from a recording medium to detect an information signal and/or an error signal; and a second photo-detector which receives the second and third light beams reflected from a recording medium to detect information signals and/or error signals.

[Representative Drawing]

FIG. 1

SPECIFICATION

[Title of the Invention]

Compatible Optical Pickup

[Brief Description of the Drawings]

FIG. 1 is a schematic view showing the optical structure of an optical pickup, according to an embodiment of the present invention;

FIG. 2 is a schematic view showing paths through which light beams condensed by first and second objective lenses of FIG. 1 are irradiated onto optical discs with different thicknesses;

FIG. 3 is a schematic plan view of an embodiment of a second photo-detector of FIG. 1;

FIG. 4 is a schematic plan view of another embodiment of the second photo-detector of FIG. 1;

FIG. 5 is a view showing a case where the second objective lens tilts with respect to the first objective lens by θ due to an assembly error, in an optical pickup of FIG. 1; and

FIG. 6 is a view showing an example in which the first and second objective lenses of FIG. 1 are arrayed within a movement distance satisfying Equation 3.

<Explanation of Reference Numerals Designating the Major Elements of the Drawings>

10, 20 . . . first and second optical unit	11 . . . single light source
11a, 21a, 21b . . . first through third light beams	17, 30 . . . photo-detector
21 . . . twin light source	40 . . . actuator
45, 41 . . . first and second objective lenses	50 . . . lens holder

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art prior to the Invention]

The present invention relates to a compatible optical pickup, and more particularly, to a compatible optical pickup which can be compatibly used for three types of recording media by using light beams with different wavelengths.

In an optical recording and/or reproducing apparatus which records information on and/or reproduces information from an optical information storage medium, such as an optical disc, by using a light spot condensed by an objective lens, recording capacity is determined by a size of the light spot. A size S of a light

spot is determined by a wavelength λ of used light and a numerical aperture (NA) of the objective lens as represented in Equation 1:

$$S \,\alpha\, \lambda / NA \qquad ...(1)$$

Accordingly, in order to reduce a size of a light spot focused on an optical disc to highly densify the optical disc, a short wavelength light source such as a blue violet laser and an objective lens with an NA of more than 0.6 are required.

Also, when θ denotes a tilt angle of the optical disc, n denotes a refractive index of the optical disc, d denotes the thickness of the optical disc, and NA denotes an NA of the objective lens, a coma aberration W_{31} caused by a tilt of the optical disc can be represented as in Equation 2:

$$W_{31} = -\frac{d}{2}\frac{n^2(n^2-1)\sin\theta\cos\theta}{(n^2-\sin^2\theta)^{5/2}}NA^3 \qquad ...(2)$$

wherein the refractive index n and the thickness d of the optical disc refer to an refractive index and the thickness of an optical medium ranging from a light incidence surface to a recording surface.

As can be seen in Equation 2, in order to secure a tolerance by the tilt of the optical disc, the thickness of the optical disc must be reduced with an increase in the NA of the objective lens for high density. For example, a compact disc (CD) has the thickness of 1.2mm, the thickness of a digital versatile disc (DVD) is reduced to 0.6mm, and a next generation DVD with recording capacity of more than 20GB, which is currently in progress of standardization and development and stores high definition (HD) moving picture information, is highly likely to be manufactured to the thickness of 0.1mm. Of course, in a case of the CD, the NA of the objective lens was 0.45. However, in a case of the DVD, the NA of the objective lens is increased to 0.6. In a case of the next generation DVD, the NA of the objective lens is highly likely to increase to more than 0.6, for example, 0.85. Also, in view of recording capacity, the probability that a blue violet light source to emit blue violet light with a wavelength of about 405nm will be used for the next generation DVD is very high. When developing an optical information storage medium according to new standards, the compatibility with an existing optical information storage medium is problematic.

For example, since reflectance of a writable DVD (DVD-R) and a writable CD (CD-R) is considerably reduced according to the wavelength, the use of a light source to emit light with wavelengths of 650nm and 780nm is indispensable. Accordingly, in terms of the compatibility with the DVD-R and the CD-R, an optical pickup used for the next generation DVD may adopt three light sources which emit light beams with different wavelengths.

[Technical Goal of the Invention]

The present invention provides a compatible optical pickup which can be compatibly used for three types of optical information storage media with different recording densities and formats, by using three light beams with different wavelengths.

[Structure and Operation of the Invention]

According to an aspect of the present invention, there is provided a compatible optical pickup which can be compatibly used for first through third recording media having different recording densities and formats. The compatible optical pickup includes a single light source which emits a first light beam having a wavelength suitable for the first recording medium; a twin light source which emits second and third light beams respectively having wavelengths suitable for the second and third recording media; a first objective lens which condenses the first light beam to form a light spot for recording and/or reproduction of the first recording medium; a second objective lens which condenses the second and third light beams to form light spots for recording and/or reproduction of the second and third recording media; an actuator which drives the first and second objective lenses; a first photo-detector which receives the first light beam reflected from a recording medium to detect an information signal and/or an error signal; and a second photo-detector which receives the second and third light beams reflected from a recording medium to detect information signals and/or error signals.

The actuator may include a single lens holder formed so as to install the first and second objective lenses; and a magnetic circuit, which drives the single lens holder.

The single lens holder may be formed so as to install the first and second objective lenses at different heights.

When WD1 is a working distance of one of the first and second objective lenses which has a short working distance and WD2 is a working distance of the

other one of the first and second objective lenses which has a long working distance, the first and second objective lenses are installed to satisfy Equation below so as to prevent one of the first and second objective lenses, which has the short working distance, from crashing against a recording medium during loading of the recording medium and operation of the other one of the first and second objective lenses which has the long working distance:

$$WD2 \geqslant WD1$$
$$Basic\ Separating\ Distance\ of\ Objective\ LensHavingShortWorking$$
$$Distance\ with Respect to RecordingMedium = WD1 + \alpha$$
$$here, \alpha = |WD2 - WD1| \times (0.1 \sim 1.0).$$

At least one of the first and second objective lenses may be formed so that a wavefront aberration occurring mainly due to a tilt of the objective lens and a wavefront aberration occurring mainly due to a tilt of light incident on the objective lens become the same type of aberrations.

One of the first through third recording media may be a CD-family optical disc, another may be a DVD-family optical disc, and the other may be a next generation DVD-family optical disc which is more highly densified than a DVD.

The next generation DVD-family optical disc may have the thickness of about 0.1mm, a blue violet beam may be used for the next generation DVD-family optical disc, and an objective lens used for the next generation DVD-family optical disc may have a numerical aperture of more than 0.85.

Hereinafter, the present invention will be described in detail by explaining exemplary embodiments of the invention with reference to the attached drawings.

A compatible optical pickup according to an embodiment of the present invention has a structure which can be compatibly used for a next generation DVD-family optical disc (hereinafter referred to as a next generation DVD), a DVD-family optical disc (hereinafter referred to as a DVD), and a CD-family optical disc (hereinafter referred to as a CD) with different recording densities and formats. Here, one side of the next generation DVD has recording capacity of more than 20GB, more preferably, more than 23GB. Here, the next generation DVD is generally referred to as a high-definition digital versatile disc (HD-DVD).

FIG. 1 is a schematic view showing the optical structure of a compatible optical pickup, according to an embodiment of the present invention, and FIG. 2 is a

schematic view showing paths through which light beams condensed by first and second objective lenses 45 and 41 of FIG. 1 are irradiated onto a next generation DVD 1a, a DVD 1b, and a CD 1c with different thicknesses.

Referring to FIGS. 1 and 2, the compatible optical pickup uses a high-density optical system for the next generation DVD 1a and a low-density optical system for the DVD 1b and the CD 1c and shares an actuator 40, so as to be compatibly used for a plurality of optical discs with different recording densities and thicknesses.

The compatible optical pickup includes an optical unit, the first and second objective lenses 45 and 41, and the actuator 40. The optical unit emits first, second, and third light beams 11a, 21a, and 21b with suitable wavelengths for the next generation DVD 1a, the DVD 1b, and CD 1c toward an optical disc 1 and receives the first, second, and third light beams 11a, 21a, and 21b reflected from the optical disc 1 to detect information signals and/or error signals. The first and second objective lenses 45 and 41 condense incident light beams to focus the incident light beams as a light spot on a recording surface of the optical disc 1. The actuator 40 moves the first and second objective lenses 45 and 41 in a focusing direction and/or a tracking direction.

As shown in FIG. 1, the compatible optical pickup may have a structure in which the first, second, and third light beams 11a, 21a, and 21b emitted from the optical unit are reflected from reflective mirrors 37 and 35 toward the first and second objective lenses 45 and 41. The compatible optical pickup may have a structure in which the first, second, and third light beams 11a, 21a, and 21b emitted from the optical unit are directly incident on the first and second objective lenses 45 and 41 by excluding the reflective mirrors 37 and 35.

The optical unit includes a first optical unit 10, a second optical unit 20, and a first collimating lens 18, and a second collimating lens 23. The first optical unit 10 emits the first light beam 11a with a wavelength suitable for the next generation DVD 1a and receives the first light beam 11a reflected from the optical disc 1 to detect an information signal and/or an error signal. The second optical unit 20 emits the second and third light beams 21a and 21b with wavelengths suitable for the DVD 1b and the CD 1c and receives the second and third light beams 21a and 21b reflected from the optical disc 1 to detect information signals and/or error signals. The first collimating lens 18 is disposed between the first optical unit 10 and the reflective

mirror 37 for the next generation DVD 1a, and the second collimating lens 23 is disposed between the second optical unit 20 and the reflective mirror 35.

When the compatible optical pickup has the above-described structure, the compatible optical pickup can be compatibly used for the next generation DVD 1a, the DVD 1b, and the CD 1c.

As shown in FIG. 1, the first optical unit 10 may include a blue violet light source 11, a polarization beam splitter (PBS) 13, a quarter wave plate 15 with respect to the wavelength of the first light beam 11a, a photo-detector 17, and a sensing lens 16. The light source 11 emits the first light beam 11a with a blue violet wavelength suitable for the next generation DVD 1a, for example, a wavelength of 405nm. The PBS 13 transmits or reflects the first light beam 11a according to a polarization state. The quarter wave plate 15 changes the polarization state of the first light beam 11a. The photo-detector 17 receives the first light beam 11a reflected from the optical disc 1 to detect the information signal and/or the error signal. The sensing lens 16 is disposed between the PBS 13 and the photo-detector 17.

The sensing lens 16 may be an astigmatic lens which generates an astigmatism in the first light beam 11a so as to detect a focus error signal using an astigmatic method.

As shown in FIG. 1, the first optical unit 10 may further include a grating 12 which diffracts the first light beam 11a emitted from the single light source 11 into three or more beams to generate sub beams so as to detect a tracking error signal using a 3-beam method or a differential push-pull (DPP) method.

The first optical unit 10 may further include a monitor photo-detector (not shown) that detects the first light beam 11a which has been emitted from the light source 11 and a portion of which has been partially reflected by the PBS 13 for controlling the output light power of the light source 11. The first optical unit 10 may further include a condensing lens (not shown) which properly condenses the reflected portion of the first light beam 11a onto the monitor photo-detector.

Instead of including the PBS 13 and the quarter wave plate 15 for changing the proceeding path of the incident first light beam 11a according to a polarization state, the first optical unit 10 may include a plate- or cubic-type beam splitter which transmits and reflects the first light beam 11a in a predetermined ratio.

The first optical unit 10 may be a hologram optical module for a blue violet wavelength suitable for the next generation DVD 1a, for example, a wavelength of 405nm.

As well known in the art, the hologram optical module includes a light source which emits a light beam with a predetermined wavelength, a photo-detector which is disposed at a side of the light source and receives light reflected from an optical disc to detect an information signal and/or an error signal, and a hologram element which directly transmits light emitted from the light source and diffracts light reflected from the optical disc into a $+1^{st}$-order or -1^{st}-order beam toward the photo-detector. Here, it is preferable that the grating 12 and the hologram optical module are incorporated into a single body.

Here, the structure of a photo-detector for detecting a tracking error signal using the 3-beam method or the DPP method is well known in the art. Therefore, the structure of the photo-detector 17 will not be explained and shown in detail herein.

The second optical unit 20 may include a twin light source 21, a plate-type beam splitter 25, and a photo-detector 30. The twin light source 21 emits the second light beam 21a with a red wavelength suitable for the DVD 1b, for example, a wavelength of 650nm and the third light beam 21b with an infrared wavelength suitable for the CD 1c, for example, a wavelength of 780nm. The plate-type beam splitter 25 transmits and reflects the second and third light beams 21b and 21c in a predetermined ratio. The photo-detector 30 receives the second and third light beams 21a and 21b reflected from the optical disc 1 to detect the information signals and/or error signals.

The second optical unit 20 may further include a grating 22 which diffracts the second and third light beams 21a and 21b to generate sub beams so as to detect a tracking error signal using the 3-beam method or the DPP method. The grating 22 is disposed between the twin light source 21 and the plate-type beam splitter 25.

The second optical unit 20 may further include a sensing lens (not shown) which is disposed between the plate-type beam splitter 25 and the photo-detector 30 and performs a function identical or similar to that of the sensing lens 16 of the first optical unit 10. The second optical unit 20 may further include a monitor photo-detector (not shown) which monitors an output amount of the second light beam 21a and/or the third light beam 21b.

The twin light source 21 may be a twin laser diode (LD) into which two semiconductor lasers for emitting light beams with different wavelengths are modularised.

Instead of including the plate-type beam splitter 25 as an optical path changing device, the second optical unit 20 may include the PBS 13 and the quarter wave plate 15 of the first optical unit 10.

Considering that the second and third light beams 21a and 21b are emitted from the twin light source 21 so that their central axes are spaced apart from each other, and three beams split by the grating 12 are detected, the photo-detector 30 may have, for example, structures as shown in FIGS. 3 and 4.

Referring to FIG. 3, the photo-detector 30 may include a quadrant main photo-detector 31 which detects the second light beam 21a, a pair of sub photo-detectors 32a and 32b which are disposed beside two sides of the quadrant main photo-detector 31, and a quadrant main photo-detector 33 which detects the third light beam 21b, and a pair of sub photo-detectors 34a and 34b which are disposed beside two sides of the quadrant main photo-detector 33.

The quadrant main photo-detectors 31 and 33 are used to detect information signals recorded on the optical disc 1 and the focus error signal. The sub photo-detectors 32a, 32b, 34a, and 34b are used to detect the tracking error signal using the 3-beam method. The quadrant main photo-detectors 31 and 33 and the sub photo-detectors 32a, 32b, 34a, and 34b may also be used to detect the tracking error signal using the DPP method.

The structure of the photo-detector 30 of FIG. 3 is suitable for detecting an error signal by using three beams into which both the second and third light beams 21a and 21b are split, in the use of the DVD 1b and the CD 1c, and may be modified into various forms.

For example, the photo-detector 30 may have a structure, as shown in FIG. 4, in which a pair of sub photo-detectors 35 and 36 are disposed beside two sides of both the quadrant main photo-detectors 31 and 33. When adopting the DVD 1b and the CD 1c, the photo-detector 30 shown in FIG. 4 can be applied in the case of that split three beams of both the second and third light beams 21a and 21b are used to detect error signals or split three beams of one of the second and third light beams 21a and 21b are used to detect error signal and quadrant photo-detector is

only used to detect error signal with respect to other one of the second and third light beams 21a and 21b.

Even when both the second and third light beams 21a and 21b are split and then used to detect error signals, the photo-detector 30 may include the sub photo-detectors 35 and 36 as shown in FIG. 4. This is because the compatible optical pickup according to the present invention uses only the second light beam 21a during recording on and/or reproduction from the DVD 1b as the optical disc 1 or only the third light beam 21b during recording on and/or reproduction from the CD 1c as the optical disc 1. The sub photo-detector 35 corresponds to a single body into which the sub photo-detectors 32a and 32b are incorporated, and the sub photo-detector 36 corresponds to a single body into which the sub photo-detectors 34a and 34b are incorporated.

Here, the second optical unit 20 may further include an optical element, for example, a hologram coupler (not shown), which allows the proceeding paths of the second and third light beams 21a and 21b emitted at a predetermined distance from the twin light source 21 to be coincident. The hologram coupler transmits one of two light beams of different wavelengths incident at a predetermined distance and refracts the other one to allow the proceeding paths of the two light beams to be coincident. The hologram coupler is disposed between the twin light source 21 and the plate-type beam splitter 25 or between the plate-type beam splitter 25 and the photo-detector 30. In a case where the photo-detector 30 includes the optical element to allow the proceeding paths of the second and third light beams 21a and 21b to be coincident, the photo-detector 30 may have a structure corresponding to the photo-detector 17 of the first optical unit 10.

The first collimating lens 18 is disposed between the first optical unit 10 and the first objective lens 45 and changes the first light beam 11a, which has been emitted as a divergent beam from the first optical unit 10, into a parallel beam to allow the parallel beam to incident on the first objective lens 45.

In a case where the first collimating lens 18 is disposed, the first objective lens 45 is designed to be optimum for the first light beam 11a as the parallel beam.

The second collimating lens 23 is disposed between the second optical unit 20 and the second objective lens 41. The second collimating lens 23 changes the second and third light beams 21a and 21b, which have been emitted as divergent beams from the second optical unit 20, into parallel beams or almost parallel beams.

The compatible optical pickup of FIG. 1 includes the first and second collimating lenses 18 and 23 to allow the parallel beams or the almost parallel beams to be incident on the first and second objective lenses 45 and 41. However, the compatible optical pickup may not include the first collimating lens 18 and/or the second collimating lens 23 or may include the first and/or second collimating lenses 18 and 23 to allow slightly convergent or divergent beams to be incident on the first and/or second objective lenses 45 and 41 so that an optical system used for at least one of the next generation DVD 1a, the DVD 1b, and the CD 1c is an infinite optical system.

Here, the optical structure of the optical unit of the compatible optical pickup of FIG. 1 is only an example. The optical unit is not limited to the optical structure of FIG. 1. In other words, the compatible optical pickup according to the present invention includes two objective lenses 41 and 45, the single light source 11, and the twin light source 21, and other optical structures may be modified into various forms without departing from the spirit and scope of the spirit of the present invention.

It is preferable that the first objective lens 45 is provided so as to form an optimum light spot used for recording on and/or reproduction from a high-density optical disc, i.e., the next generation DVD 1a.

For example, when the first light source 11 emits the first light beam 11a with a blue violet wavelength, for example, a wavelength of 405nm, and the next generation DVD 1a has the thickness of about 0.1mm, it is preferable that the first objective lens 45 has the NA of 0.85 or more.

It is preferable that the second objective lens 41 is provided so as to form light spots used for recording on and/or reproduction from low-density optical discs, i.e., the DVD 1b and the CD 1c. In other words, it is preferable that the second objective lens 41 is optimized for the DVD 1b and is compatibly used for the CD 1c.

As will be described later, the second objective lens 41 may be a lens on which a hologram pattern is formed. Here, the hologram pattern is formed on at least a portion of one of two surfaces of the lens, preferably, at least a portion of a surface of the lens facing the optical unit so as to satisfy a optimum optical performance for the DVD 1b and the CD 1c.

In the compatible optical pickup, it is preferable that the first and second objective lenses 45 and 41 are installed in a single lens holder 50 to be driven by the single actuator 40. In this case, a relative tilt may occur between the first and

second objective lenses 45 and 41 during assembling of the first and second objective lenses 45 and 41 into the single lens holder 50.

Accordingly, it is preferable that at least one of the first and second objective lenses 45 and 41 is manufactured so that a wavefront aberration occurring mainly due to a tilt of an objective lens and a wavefront aberration occurring mainly due to a tilt of light incident on the objective lens become the same type of wavefront aberrations. For example, it is preferable that at least one of the first and second objective lenses 45 and 41 is manufactured so that a wavefront aberration occurring mainly due to a tilt of an objective lens and a wavefront aberration occurring mainly due to a tilt of light incident on the objective lens become coma aberrations.

Here, as well known in the optical field, a coma aberration occurs mainly due to a tilt of an objective lens, and an astigmatic aberration occurs mainly due to light incident on the objective lens at a predetermined angle. Accordingly, in a case of a general lens, although an incidence angle of light incident on the general lens is adjusted, it is impossible to compensate for a coma aberration occurring due to a tilt of the general lens.

However, in a case where at least one of the first and second objective lenses 45 and 41 is manufactured so that a wavefront aberration occurring mainly due to a tilt of an objective lens and a wavefront aberration occurring mainly due to light incident on the objective lens at an incident angle, i.e., a field angle, become the same type of wavefront aberrations, it is possible to compensate for a wavefront aberration occurring due to a tilt of an objective lens by adjusting an incident angle at which light is incident on the objective lens.

Accordingly, for example, when the second objective lens 41 used for a low-density optical disc is manufactured so as to compensate for the wavefront aberration occurring due to the tilt of the objective lens and the skew of the first objective lens 45 or the overall compatible optical pickup including the first objective lens 45 is adjusted to be suitable for the high-density next generation DVD 1a, as shown in FIG. 5, although the second objective lens 41 tilts with respect to the first objective lens 45 due to an assembly error, it is possible to compensate for a wavefront aberration occurring due to the tilt of the second objective lens 41. Here, the compensation for the wavefront aberration occurring due to the tilt of the second objective lens 41 is achieved in a process of moving the second optical unit 20 or the twin light source 21 within a plane perpendicular to the optical path through which

the second and third light beams 21a and 21b pass to adjust angles at which the second and third light beams 21a and 21b are incident on the second objective lens 41.

Here, the first objective lens 45 may be manufactured to compensate for a wavefront aberration occurring due to a tilt of a lens, and the skew of the second objective lens 41 or the overall compatible optical pickup including the second objective lens 41 may be adjusted to be suitable for the second objective lens 41. Also, a process of adjusting a skew to be suitable for one of the first and second objective lenses 45 and 41 may be omitted by using lenses capable of compensating for the wavefront aberration occurring due to the tilt of the lens as the first and second objective lenses 45 and 41.

In the compatible optical pickup having the above-described structure, it is possible to compensate for a wavefront aberration occurring due to a relative tilt between the first and second objective lenses 45 and 41. Therefore, even when the first and second objective lenses 45 and 41 are installed in the actuator 40 so as to keep the relative tilt therebetween, a high-quality reproduction signal can be obtained, like when the first and second objective lenses 45 and 41 do not tilt with respect to the optical disc 1.

Meanwhile, in the compatible optical pickup according to the present invention, it is preferable that the first and second objective lenses 45 and 41 are installed at different heights in consideration of their different working distances and the lens holder 50 of the actuator 40 is formed to be suitable for the different heights of the first and second objective lenses 45 and 41.

More preferably, the first and second objective lenses 45 are installed as shown in FIG. 6 to satisfy Equation 3 so that the first objective lens 45 having a short working distance cannot contact the optical disc 1 during loading of the optical disc 1 and/or operation of the second objective lens 41 within a long distance. In other words, it is preferable that a basic separating distance between the first objective lens 45 and the optical disc 1 is greater than the movement distance of the first objective lens 45. In Equation 3, WD1 denotes the movement distance of the first objective lens 45, and WD2 denotes the movement distance of the second objective lens 41.

$WD2 \geqslant WD1$

$$Basic\ Separating\ Distance\ of\ First\ Objective\ Lens\ With\ Respect\ to\ Optical\ Disc = WD1 + \alpha \quad \ldots (3)$$

$$Here, \alpha = |WD2 - WD1| \times (0.1 \sim 1.0)$$

It is preferable that the first and second objective lenses 45 and 41 are installed in direction R corresponding to a radial direction of the optical disc 1. This is because the compatible optical pickup moves in an optical recording and/or reproducing apparatus in the radial direction of the optical disc 1 to perform recording and/or reproduction of an information signal.

In a case where the first and second objective lenses 45 and 41 are disposed in parallel in the radial direction of the optical disc 1, it is preferable that the first objective lens 45 for a high-density disc is positioned at an inside diameter of the optical disc 1 compared to the second objective lens 41 for a low-density disc in view of the compatibility with a cartridge for an existing recordable DVD.

As described above, in a case where the first and second objective lenses 45 and 41 are disposed in parallel in the radial direction of the optical disc 1, an optical recording and/or reproducing apparatus adopting the compatible optical pickup according to the present invention includes a spindle motor 19 smaller than an existing spindle motor to rotate the optical disc 1, so as to read information recorded in the outermost track during reproduction from the DVD 1b and/or the CD 1c using the second objective lens 41 which is positioned at an outer diameter of the optical disc 1 compared to the first objective lens 45.

As described above, in a case where the first and second objective lenses 45 and 41 are disposed in parallel in the radial direction of the optical disc 1, it is preferable that the first and second objective lenses 45 and 41 and the spindle motor 19 line up to harmonize phases of tracking signals at inner and outer perimeters of the compatible optical pickup.

Here, the arrangement of the first and second objective lenses 45 and 41 is not limited to the radial direction of the optical disc 1 and may be modified into various forms.

For example, the compatible optical pickup according to the present invention may include an axis perturbation actuator to dispose the first and second objective lenses 45 and 41 on appropriate positions in a switching way. Even when the axis

perturbation actuator is used, it is preferable that the basic separating distance between the first and second objective lenses 45 and 41 and the optical disc 1 satisfies Equation 3.

The actuator 40 may be a biaxial actuator which moves a moving unit mounted in the first and second objective lenses 45 and 41 having different working distances in an optical axis direction and the radial direction of the optical disc 1, i.e., a focusing direction and a tracking direction, or may be a triaxial actuator which performs a tilting movement in addition to biaxial movements.

In the compatible optical pickup according to the present invention, it is preferable that the actuator 40 is a single structure actuator in which the first and second objective lenses 45 and 41 are mounted in the single lens holder 50.

In other words, the actuator 40 includes the single lens holder 50 which is formed to install the first and second objective lenses 45 and 41 having different working distances and a magnetic circuit 55 which moves the first and second objective lenses 45 and 41 mounted on the single lens holder 50 in the focusing direction, the tracking direction, and/or the tilting direction.

Here, it is preferable that the single lens holder 50 is formed so that the first and second objective lenses 45 and 41 are installed to satisfy Equation 3 so as to prevent the first objective lens 45 having the short working distance from interfering with the optical disc 1 during initial loading of the optical disc 1 and/or the operation of the second objective lens 41 having the long working distance.

Also, it is preferable that the single lens holder 50 is formed so as to install the first and second objective lenses 45 and 41 in the radial direction of the optical disc 1. This is because the compatible optical pickup moves in the radial direction of the optical disc 1 in an optical disc drive to record an information signal on and/or reproducing the information signal from the optical disc 1.

It is preferable that the single lens holder 50 is formed so as to dispose the first objective lens 45 at the inside diameter of the optical disc 1 compared to the second objective lens 41.

Here, the compatible optical pickup according to the present invention may include two actuators which each include the first and second objective lenses 45 and 41 to be separately driven.

As described above, in the compatible optical pickup according to the present invention, a skew of the first objective lens 45 used for the next generation DVD 1a

can be adjusted to prevent the first objective lens 45 from tilting with respect to the optical disc 1. Also, the second objective lens 41 used for the DVD 1b and the CD 1c may be a lens which is manufactured to compensate for a wavefront aberration occurring due to a tilt thereof. Thus, in a case where a relative tilt between the first and second objective lenses 45 and 41 occurs, angles at which the second light beam 21a for the DVD 1b and the third light beam 21b for the CD 1c are incident on the second objective lens 41 can be adjusted to prevent an optical performance of the compatible optical pickup from deteriorating due to the relative tilt.

The compatible optical pickup according to the present invention may have an optical structure in which the first objective lens 45 is designed to be suitable for the next generation DVD a and compensate for a wavefront aberration occurring due to a tilt thereof like the second objective lens 41 so as to omit a process of adjusting a skew.

The compatible optical pickup may have an optical structure in which a skew of the second objective lens 41 used for the DVD 1b and/or the CD 1c is adjusted to be coincident with an optical axis and the first objective lens 41 used for the next generation DVD 1a is designed to so as to compensate for a wavefront aberration occurring due to a tilt thereof.

It has been described that the compatible optical pickup according to the present invention includes the single light source 11 used for the next generation DVD 1a, the first objective lens 45 suitable for the next generation DVD 1a, the twin light source 21 used for the DVD 1b and the CD 1c, and the second objective lens 41 suitable for the DVD 1b and the CD 1c so as to be compatibly used for three types of optical discs with different recording densities, for example, the next generation DVD 1a, the DVD 1b, and the CD 1c, to perform recording and/or reproduction. However, the compatible optical pickup according to the present invention is not limited to this and may be modified into various forms without departing from the spirit and scope of the present invention as defined by claims.

For example, the compatible optical pickup according to the present invention may include a twin light source used for the next generation DVD 1a and the DVD 1b, an objective lens suitable for the next generation DVD 1a and the DVD 1b, a single light source used for the CD 1c, and an objective lens suitable for the CD 1c.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of

ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

[Effect of the Invention]

Accordingly, the compatible optical pickup according to the present invention may be compatibly used for three types of recording media using two objective lenses and three light beams with different wavelengths.

Here, when the two objective lenses are installed in consideration of their working distances with respect to a plurality of optical information storage media having different recording density and formats, an objective lens having a short working distance, can be prevented from crashing against an optical disc.

What is claimed is:

1. A compatible optical pickup which can be compatibly used for first through third recording media having different recording densities and formats, comprising:

a single light source which emits a first light beam having a wavelength suitable for the first recording medium;

a twin light source which emits second and third light beams respectively having wavelengths suitable for the second and third recording media;

a first objective lens which condenses the first light beam to form a light spot for recording and/or reproduction of the first recording medium;

a second objective lens which condenses the second and third light beams to form light spots for recording and/or reproduction of the second and third recording media;

an actuator which drives the first and second objective lenses;

a first photo-detector which receives the first light beam reflected from a recording medium to detect an information signal and/or an error signal; and

a second photo-detector which receives the second and third light beams reflected from a recording medium to detect information signals and/or error signals.

2. The compatible optical pickup of claim 1, wherein the actuator comprises:

a single lens holder formed so as to install the first and second objective lenses; and

a magnetic circuit, which drives the single lens holder.

3. The compatible optical pickup of claim 2, wherein the single lens holder is formed so as to install the first and second objective lenses at different heights.

4. The compatible optical pickup of claim 3, wherein when WD1 is a working distance of one of the first and second objective lenses which has a short working distance and WD2 is a working distance of the other one of the first and second objective lenses which has a long working distance, the first and second objective lenses are installed to satisfy Equation below so as to prevent one of the first and second objective lenses, which has the short working distance, from

crashing against a recording medium during loading of the recording medium and operation of the other one of the first and second objective lenses which has the long working distance:

$$WD2 \geqslant WD1$$
$$Basic\ Separating\ Distance\ of\ Objective\ Lens Having Short Working$$
$$Distance\ with\ Respect\ to\ Recording Medium = WD1 + \alpha$$
$$here, \alpha = | WD2 - WD1 | \times (0.1 \sim 1.0).$$

5. The compatible optical pickup of claim 4, wherein at least one of the first and second objective lenses is formed so that a wavefront aberration occurring mainly due to a tilt of the objective lens and a wavefront aberration occurring mainly due to a tilt of light incident on the objective lens become the same type of aberrations.

6. The compatible optical pickup of claim 4, wherein one of the first through third recording media is a CD-family optical disc, another is a DVD-family optical disc, and the other is a next generation DVD-family optical disc which is more highly densified than a DVD.

7. The compatible optical pickup of claim 1, wherein the second photo-detector comprises first and second main photo-detectors which receive the second and third light beams, respectively.

8. The compatible optical pickup of claim 7, further comprising:

a grating which diffracts the second and/or third light beams emitted from the twin light source into at least three beams,

wherein the second photo-detector further comprises a plurality of sub photo-detectors which receive sub beams split by the grating.

9. The compatible optical pickup of one of claims 1 to 3, wherein at least one of the first and second objective lenses is formed so that a wavefront aberration occurring mainly due to a tilt of the objective lens and a wavefront aberration

occurring mainly due to a tilt of light incident on the objective lens become the same type of aberrations.

10. The compatible optical pickup of claim 9, wherein at least one of the first and second objective lenses is formed so that a wavefront aberration occurring mainly due to a tilt of the objective lens and a wavefront aberration occurring mainly due to a tilt of light incident on the objective lens become coma aberrations.

11. The compatible optical pickup of one of claims 1 to 3, wherein one of the first through third recording media is a CD-family optical disc, another is a DVD-family optical disc, and the other is a next generation DVD-family optical disc which is more highly densified than a DVD.

12. The compatible optical pickup of claim 11, wherein the next generation DVD-family optical disc has the thickness of about 0.1mm, a blue violet beam is used for the next generation DVD-family optical disc, and an objective lens used for the next generation DVD-family optical disc has a numerical aperture of more than 0.85.

FIG. 1

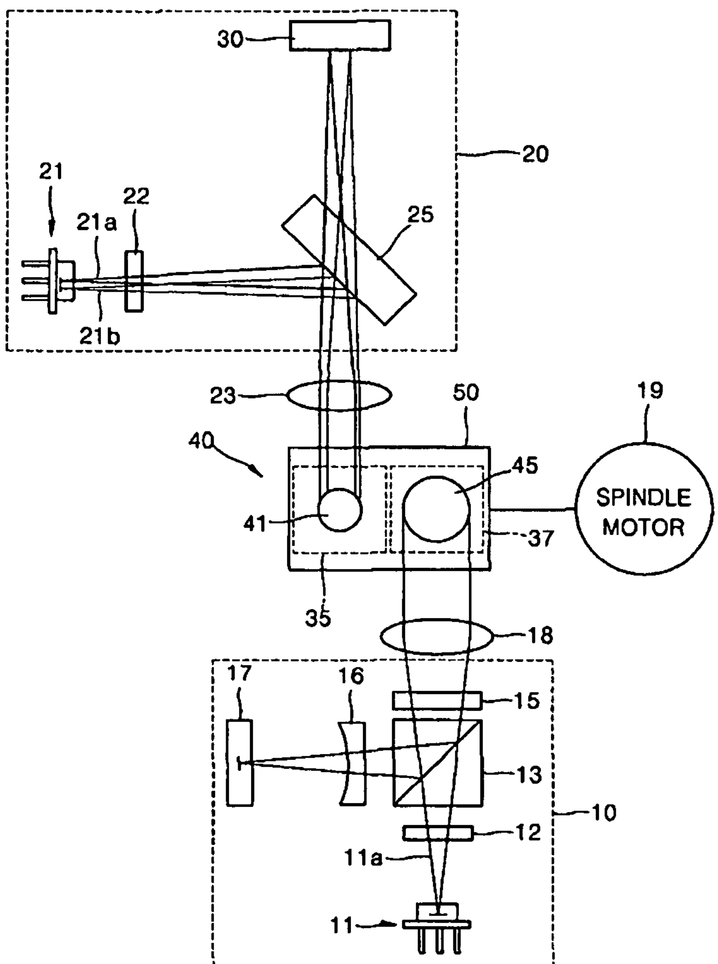
30
20
21
22
21a
25
21b
23
50
19
40
45
SPINDLE
MOTOR
41
37
35
18
17
16
15
13
10
12
11a
11

FIG. 2

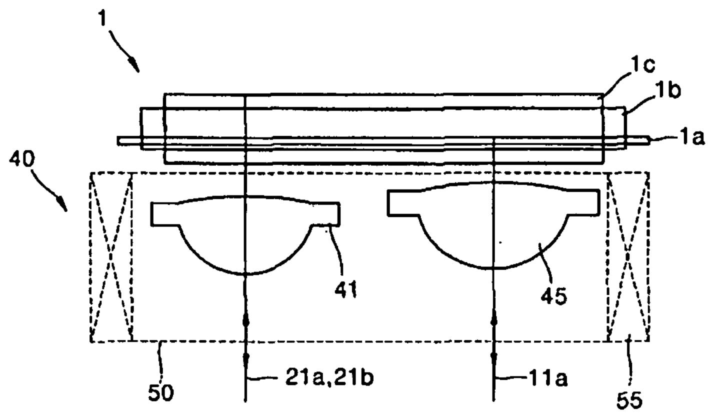

FIG. 3

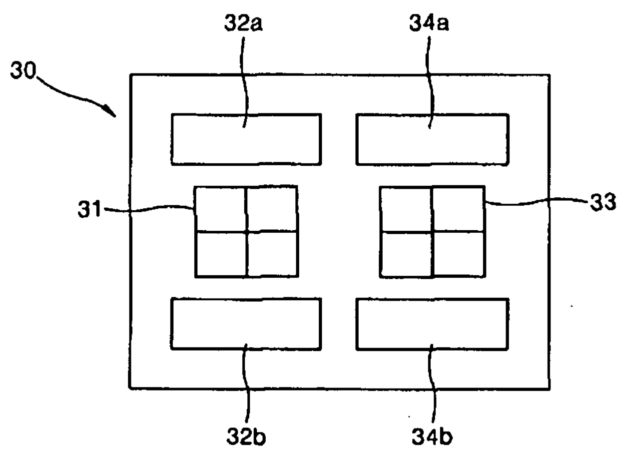

FIG. 4

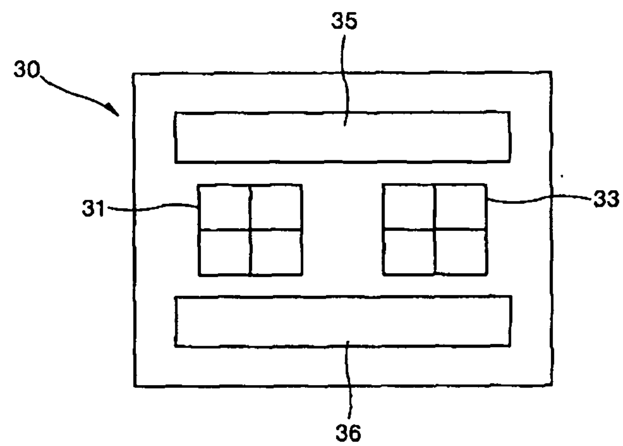

FIG. 5

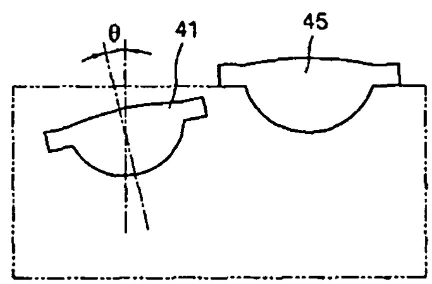

FIG. 6